

Next Generation Video Evidence Storage and Management for Police Forces

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1. ABSTRACT

Introduction: The rapid employment of video evidence in criminal cases is generating millions of hours of video footage that must be archived and managed if it is to be of evidential use by the Crown Prosecution System.

Mandate: Evidential material must now be kept in its entirety for 7 years or for the period of the allocated sentence plus 1 year and a day, whichever is the longer. This is so that, at any time if the defence lawyer appeals, it is available for review.

Traditional solutions: VHS tapes are put in warehouse-type storage for the duration, alongside thousands of other police VHS tapes. Hence, most video evidence that is recorded on VHS tape can be easily and cheaply stored in the original format. As the police move towards digital technology and analogue recording devices are replaced by digital devices, the storage medium for the digitised video footage becomes more expensive and the need for a managed, centralised, intelligent data archiving solution becomes imperative.

The driver for a new solution: The adoption of digital technology is now raising significant economic, logistical and practical challenges for the police and is driving the need for a completely new approach to video data storage.

2. INTRODUCTION

Video is a groundbreaking weapon in the fight to capture and convict those who seek to challenge our security and to break the law. In fact, the most prolific source of evidence collected by the police and other security agencies today is video images of criminal activity, captured by millions of CCTV and surveillance cameras and seized video material from DVRs, computers and mobile phones. Evidence captured on video has been found to be more accurate, more reliable, and more convincing than eyewitness testimony alone.

The rapid employment of video evidence in criminal cases is generating millions of hours of video footage that must be archived and managed if it is to be of evidential use by the Crown Prosecution System. This paper will discuss the evidential video data storage and management needs of police forces, how the problem is currently dealt with, the challenges of the digital revolution and the need for a new secure, centrally administered, cost-effective, intelligent video archive and management system.

3. MANDATED GUIDELINES FOR VIDEO EVIDENCE STORAGE

At the moment individual police forces employ several disparate systems for video evidence collection and archiving. Historically, video surveillance footage has been recorded on VHS tape. However, as the police move towards digital technology and analogue recording devices are replaced by digital

devices, the storage medium for the digitised video footage becomes more expensive and more susceptible, in the eyes of the public, to manipulation.

Advisory guidelines relating to video and computer based evidence have been set by CENTRAX (previously NSLEC, but to become NPIA (the National Policing Improvement Agency) in April 2007) and PSDB, but there is currently no coherent policy for their adoption by Police Forces in the UK. To the best of our knowledge, the PSDB guidelines state that any recorded evidential material can be backed up, if it is a bit-for-bit copy of the original. For example, if video evidence is collected directly onto a DVD, it can be backed up bit-for-bit onto another DVD. If the video evidence is directly stored onto a digital video recorder (DVR) hard drive, then this cannot be copied to a DVD as this is not a bit-for-bit copy, and hence expensive hard drives have become the permanent storage medium of choice.

Importantly, it is also now mandatory for Police Forces in the UK to retain all video footage captured during police operations for a period of seven years, or the length of the sentence a defendant receives as a result of the operation plus one year and a day; whichever is greater.

It does not matter how much of the video footage is actually submitted as evidence in a defendant's trial; all footage captured must be stored and preserved in its original native format for the purposes of defending a civil claim or appeal in the future, which might call on that evidence gathered during the operation but not presented by the prosecution counsel.

TSUs (Technical Support Units) and other video surveillance-capable departments are now capturing video footage in digital format. This is having a dramatic effect already, with thousands of VHS tapes or hard disks being replaced and archived every week across the country, since footage must be retained in its original format.

4. CURRENT PRACTICES AND EMERGING PROBLEMS

A. Technical Support Units and Video Surveillance

VHS surveillance tapes: Traditionally, VHS surveillance tapes that are either gathered by TSUs or seized, are put in warehouse-type storage for the required duration, alongside thousands of other police VHS tapes. Hence, most video evidence that is recorded on VHS tape can be easily and cheaply stored in the original format in isolated warehouses around the country. The problem therein, lies in the fact that there is no universal system used for archiving and retrieving the tapes in store, creating logistical problems at local, national and international level. Some Police Forces, such as the Birmingham Police Force, still predominantly use VHS tapes, and their awareness of digital storage issues is poor. They have little perception of the future problems they will encounter, and they need to be persuaded to forward plan and manage their evolution to new solutions.

DVR recording of surveillance operations: Police Forces are moving towards using DVRs or for police operations at a variable rate. Some, such as the Kent Police Force, have moved over almost completely and have recently become aware of the problems of evidential video storage with this new more expensive medium.

Some surveillance recording devices, such as Ovation's Afterburner, burn the video directly to DVD. This is a relatively inexpensive means of data archiving. A widely used alternative is to record directly to a hard drive within a DVR. Each TSU and their related regional surveillance operatives and partners that are using digital medium, have large numbers of hard disk-based DVRs deployed at any one time. These devices are purchased from many different manufacturers, including Dedicated Micros and other popular providers of proprietary devices. Currently these devices are usually configured to record a week's worth of video footage on the available portion of their hard disks, which are then removed in caddies and replaced with new drives, while the old drives are archived in physical store and catalogued using a manual indexing system. Mirroring the physical archiving strategy for VHS tapes with removable DVDs or DVR hard drives can be a prohibitively expensive solution that does not address the logistical issues of evidential data management and retrieval.

B. Audio Visual Laboratories and Video Data Retrieval

Working predominantly with third-party video footage collected on site by officers during an enquiry, the AV teams gets a multitude of video formats on mainly optical media. Typically these DVDs and CD-ROMs are given a catalogue/database number ID in their Access based database, then archived in a physical library. The storage requirements of this department are not anticipated to be particularly high, although more intelligent data retrieval, presentation, archiving and management tools would be advantageous.

5. DESIRABLE FEATURES OF A DISTRIBUTED VIDEO DATABASE SOLUTION

The proposed Video Database (to be hereafter called 'VDB') solution must deliver the following tangible benefits to Police Forces (to be referred to also as 'the customer'):

1. Facilitate the storage of video evidence in a multitude of (often proprietary) formats in a singly accessible, uniquely addressable data warehouse.
2. Store surveillance footage as 'Primary Evidence' in the native format of the device on which it was recorded or captured, for a mandatory period of seven years, or in the case of trials where the defendant is sentenced to a term longer than seven years; for that period plus 1 year.
3. Store CCTV and DVR footage, as captured by the user from a CD or DVD, in a file format which is space efficient and of a suitably high quality for the applications of the Audio Visual laboratory.
4. Reduce the time spent on the 'housekeeping' of video evidence by unifying storage locations, access methods and storage media across the force.
5. Reduce the amount of hard disk drives used by TSUs in their maintaining of video surveillance operations across the country.
6. Allow users to remotely access the data store for the purposes of uploading and downloading video evidence from their Force network terminals.

7. Provide central and satellite access points at which video can be uploaded to the system, which will likely be managed by the customer's regional CCTV and TSU Liaison Officers. The key point here is to reduce network overheads by allowing users to upload video directly to the data store.
8. Facilitate the addition of intelligence to the video stored in the form of meta data – and further, to allow this meta data to be added to manually (in the form of text notes) or automatically in the future (by way of automated filters such as Scyron's Video Inspector, Video Motion Detection and ANPR).
9. The data warehouse should be deployed as a single distributed data centre with allowances for fault tolerance, redundancy, and contingency options.

Essentially this VDB solution will provide a flexible, scalable, intuitive front-end to what would be one of the largest data warehouses in operation in the United Kingdom. As the customer's requirements and practices will change during the lifetime of this project, it is imperative that the solution is adaptable, dependable and robust.

6. A CASE STUDY

The Audio Visual Laboratory

The amount of video storage capacity required by an AV laboratory are likely to be in the region of 3 TB per year, based on the following calculation:

The unit receives 3,000 CDs per year with an average of 300MB of data captured from each.

$3,000 \text{ discs} \times 300\text{MB} = 9,000\text{MB}$ or 879 GB

In addition to this there is a further 5 to 10 GB of video evidence captured each day by way of CCTV feeds, video from custody suites, handheld and body mounted personal video recorders (PVRs), etc.

$7.5 \text{ GB (average)} \times 5 \text{ days} = 37.5 \text{ GB per week}$

$37.5 \text{ GB} \times 52 \text{ weeks} = 1,950 \text{ GB per year}$

So, in total, the estimate for the AV Unit's annual video storage data requirement is as follows:

$1,950 \text{ GB} + 879\text{GB} = 2,829 \text{ GB}$ or **approximately 3 TB.**

The Technical Support Unit

The amount of video storage capacity required by a TSU is likely to be in the region of 400 TB per year, based on the following calculation:

120 DVRs x 65 GB used for surveillance = 7,800 GB per week

7,800 GB x 52 weeks = 405,600 GB per year or approximately **400 TB**.

Combined Requirements

For a medium sized police force, an estimated total of **403 TB** of storage is required for each year's video evidence data at a conservative rate of capture.

7. STORAGE MEDIUMS AND OPTIONS

It is probably desirable that the video footage stored within the proposed solution is readily accessible, from a fast and reliable medium.

Archiving onto magnetic tape after a period of three years is one possibility, as after this point is it very rarely that video evidence is accessed, and a waiting time of several hours for video retrieval would be acceptable.

In between the one and three year points it is probable that a cheaper storage medium will be suitable other than the high availability, high performance one used for storing video under a year old. However it is worth considering that recent changes in the mass storage marketplace indicate that the highest performance disk arrays are also the most cost-effective.

Another factor that must be considered at this stage is that of fault tolerance. The proposed solution will not only be critical to the operation of several key Police departments, but it will also be the only store of primary evidence from surveillance operations. For these reasons a policy of fault tolerance at component level, combined with off-site replication of critical system components must be enforced.

Petabyte Disk Arrays

It seems appropriate that the prototype solution developed should include the first three years' storage capacity based on the estimates made for the Kent Police. This would mean a first deliverable of a 1.2 PB (petabyte) disk array (for the moment discounting redundancy).

Two examples of commercially available disc array are EMC and the other Fujitsu.

The EMC Symmetrix DMX-3 solution configured with 1.2 PB of storage (comprising 2,400 x 500 GB disks in 9 full rack enclosures) cost approximately US \$3 million.

The Fujitsu ETERNUS8000 solution also features data encryption within the disk drives, which may be specifically attractive or not to the customer. No pricing information on this solution was available at the time of writing this report.

8. FRONT END AND CLIENT FUNCTIONALITY

With the data warehouse sitting behind the presentation mechanism of the VBD solution, it is imperative that effective, efficient access is granted to users who are submitting requests to the system. It has been suggested that a combination of proprietary (possibly stand-alone) and Internet Explorer–driven clients are available to users, so that maximum access potential can be enabled for users across the Police Force using a combination of stand alone (Internet enabled) and network terminals (typically thin client environment ‘WinTerms’ based on Citrix).

It is estimated that in a medium sized force there could be 30–50 users with access to the system for the purposes of searching the video evidence and downloading it to their workstation. Predominantly the users will be searching for the video they require by submitting requests to database, which has been populated with the input of human operators, criteria might include:

- Unique reference (key field)
- Date
- Time
- Officer name
- Officer number
- Location
- Operation details
- Text notes added at the time of uploading the footage
- Etc

This area of the solution is the one anticipated to see the most dramatic changes to functionality in future, when additional intelligence may be added to video stored, including Smart Extractor, Video Inspector, GPS data, Tetra triangulation location data, ANPR data, and so on.

9. VIDEO UPLOAD MECHANISM AND FUNCTIONALITY

It is anticipated that the responsibility for uploading video footage to the system will be the specific remit of several key individuals in each Police Force, nominated for their geographical location and current responsibilities with regard to the management of video evidence. For example, there can be around six regional Operational Command Units (OCUs) within a medium sized police force, and each has a TSU/CCTV Liaison Officer. These individuals would most likely form the bulk of the video evidence uploading team, along with members of the AV unit and force TSU.

An efficient method by which video can be deposited in the system needs to be conceived, with the consideration of remote access for the purposes of uploading to be possible in the event of a major incident or enquiry, when video evidence volumes for both captured and working footage will increase substantially. For normal day-to-day operations it was suggested that video be uploaded to

the system via a local means (physically at the site of the data centre(s) potentially) in order to reduce the overhead the system has on the existing force network.

A future development of the project may be where an intelligent video analysis system such as Scyron's Video Inspector could be utilised as suitable footage was uploaded to the system – processing it in real time and storing meta data which could later be searched by users. Similar functionality could be added in the form of ANPR or vehicle detection/recognition technology.

From a commercial perspective, it will be necessary to involve additional companies/organisations at an early stage to aggregate the setup and development costs of the solution; while immediately widening the remit of the project, its functionality and ultimately the benefits delivered to the Police Force.

10. THE COMPANY

Founded in 2002, Scyron Ltd has developed and patented worldwide a technology platform for automated and intelligent retrieval, analysis and management of video footage from CCTV, pre-recorded (surveillance) footage and live sources.

The core technology has given rise to the range of products that are described in the pages that follow.

Our existing customers include Divisional Operation Teams, Surveillance Units, Covert Units, Video Imaging Units, Professional Standards and Force Intelligence Bureaus in UK regional police forces.

In addition to these, we have customers within nationalised forces including British Transport Police and organisations such as Transport for London and other transport providers, local authorities and forensics professionals. Our products are also distributed in the United States, France, Singapore, among other countries.

Scyron sells software solutions for automated video surveillance that facilitate:

- ❖ Automated video analysis, with products that scan pre-recorded or live video footage from surveillance operations for significant events
- ❖ Automated covert surveillance that sends encrypted video data over a wireless or mobile network
- ❖ Video management, data archiving and video retrieval
- ❖ Video and audio camouflaging/enhancement/disguising of objects, suspects and number plates, for example, to prepare video based evidence for court, for compliance with the Data Protection Act and for video identity parades.
- ❖ The company also develops advanced patented intelligent video management systems, which enable real-time remote viewing of targeted areas (using mobile and wireless networks),

analysis of behaviour in scenes obtained directly from security cameras and existing camera installations or recorded material.

11. SUMMARY

While the scale of this project is very large by perception, it is ultimately quite a straight forward solution approach to an existing problem, addressing a latent need of the customer.

It seems that Police Forces have no choice but to implement a solution that will at once remove the need for replacing thousands of expensive hard disk drives per week, and allow them to add intelligence to video evidence stored, while making it accessible across the network and therefore improve performance and efficiency force wide.

The development of a data warehouse for video and digital imagery is a clear and compelling business case. The project will require a mix of skills and market experience, and it is proposed to form a small consortium of industry partners who will collaborate in the deployment of such a solution.

12. Appendix 1 – The bigger Picture

The Bigger Picture

